Comp 451: Design and Analysis of Cyber-Physical Systems

Department of Computer Science
Rice University
Houston, Texas 77005-1892

This course is an introduction to cyber-physical systems, engineering artifacts in which computational components interact with and typically control physical components. Some common examples of cyber-physical systems include robots, Segways, and lane-departure warning (LDW) systems in automobiles. Since cyber-physical systems involve both physical and computational elements, the field is inherently interdisciplinary, drawing on aspects of software engineering, computer science, mechanical and electrical engineering, and many other disciplines in science and engineering.

The design of cyber-physical systems is a particularly challenging form of software engineering because the behavior of physical components is much more difficult to model accurately than computational components. In this course, students will learn how to analyze and design cyber-physical systems by evaluating and developing high-level executable prototypes of a variety of cyber-physical systems. These prototypes consist of physical elements modeled as hybrid systems using differential equations and computational elements that sense and control the state of the physical elements. The prototyping environment graphically depicts the behavior of the modeled cyber-physical system. The course leads students through a series of more challenging design projects culminating in a major project such as a robot that plays ping-pong. Some of the topics covered in the course include: hybrid systems, control theory, modeling computational systems, communication within cyber-physical systems, and game theory.